Effects of Gamma-Ray Irradiation on Selenium and Cuprous Oxide Rectifiers

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The effects of radiation on some electronic materials have already been reported by the authors. In the present paper, some radiation effects on selenium and cuprous oxide rectifiers irradiated with intense γ-rays from Co^{60} are reported. The gamma-ray irradiation facility used in this experiment contains approximately 1940 curies of Co^{60} in total, and the irradiation dose rate is 2.3×10^5 roentgens per hour which was estimated by the Fricke chemical dosimetry. Irradiations were accomplished at room temperature. The specimens used were not-painted plates with dimensions of about 10 mm in diameter and 1 mm in thickness.

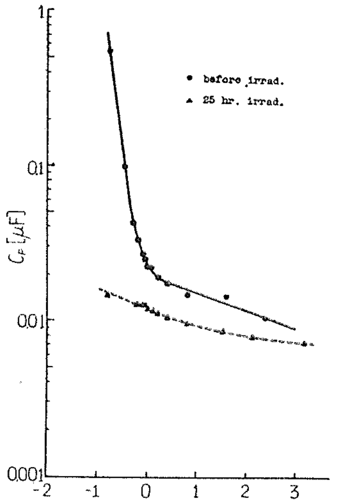

Fig. 1.

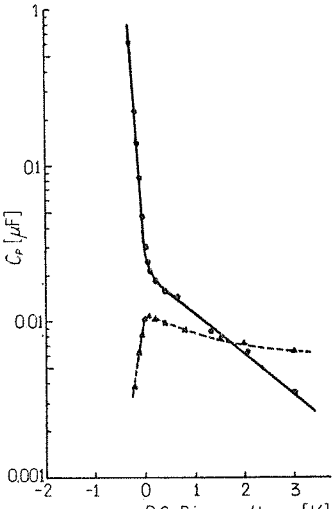

Fig. 2.

Figs. 1 and 2 show the effect on barrier capacitance as a function of dc bias voltage for selenium and cuprous oxide rectifiers, respectively. It is immediately seen that the barrier capacitance decreases with irradiation, and its slope to dc bias voltage decreases gradually with irradiation. These measurements were made at 1 kcps. In general, the barrier capacitance C_p is given by

$$C_p=\left[\frac{q\varepsilon\varepsilon_0 N}{2(V_b+V_d)}\right]^{\frac{1}{2}}, \qquad (1)$$

where q is the electronic charge, ε is the dielectric constant, $\varepsilon_0=8.85\times10^{-12}$

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Table 1.

Specimen		V_a (V) Before irrad.	After irrad.
Se	No. 2	0.45	0.90
	No. 5	0.25	0.50
Cu_2O	No. 3	0.07	0.27
	No. 4	0.08	0.26

Table 2.

Specimen		N (m^{-3}) Before irrad.	After irrad.
Se	No. 2	3.81×10^{21}	2.28×10^{21}
	No. 5	3.71×10^{21}	2.82×10^{21}
Cu_2O	No. 3	0.99×10^{21}	0.54×10^{21}
	No. 4	1.23×10^{21}	0.68×10^{21}

farad/m, N is the impurity concentration – donors for selenium and acceptors for cuprous oxide –, V_b is the dc bias voltage, and V_d is the diffusion potential. It is obviously seen from equation (1) that $1/C_p$ and (V_b+V_d) are in linear relation, and so immpurity concentration and diffusion potential are given from equation (1) graphically. The results when $\varepsilon=10$ are presented in Tables 1 and 2.

The effect on rectifying characteristics for selenium and cuprous oxide is shown in Figs. 3 and 4, respectively. These results show that both forward

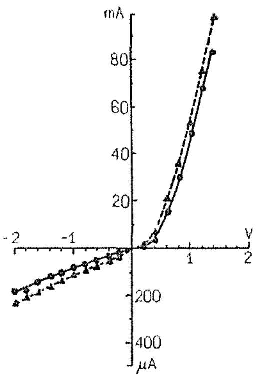

Fig. 3.

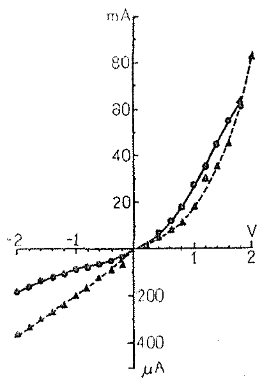

Fig. 4.

and reverse currents for selenium were increased, but for cuprous oxide the forward current was decreased and the reverse current was increased by 25 hours irradiation. But, for a few samples of cuprous oxide the forward and reverse currents were decreased by the irradiation. The effects on rectifying characteristics and on barrier capacitance seem to be inconsistent. However, V_d and N estimated from the measurements at 1 kcps while rectifying characteristics was measured at dc. Therefore it is unreasonable that they are connected directly. As seen in Fig. 2, the barrier capacitance had be increased conspicuously by positive bias voltage before irradiation, but was decreased after irradiation. For the unirradiated specimen, it seems that barrier capacitance at 100 kcps decreases with positive bias voltage. Consequently it may be expected that this peculiarity shifts to lower frequency. More detailed experiment of this phenomena is now in progress.